Marshall Space Flight Center (MSFC) EMI Test Facility (METF)
MIL-STD-461E EUT Test Questionnaire
2/16/06

Please complete this Equipment Under Test (EUT) questionnaire along with the MSFC Form 4404 (EMI Customer Agreement Form). EMI test coordination must begin with or (preferably) prior to Form 4404 submission. Failure to coordinate all test details and satisfactorily resolve test issues in a timely manner prior to the scheduled test start date will result in a delayed test start date and program schedule impacts.

EMI Test Technical Issues

1. The Equipment Under Test (EUT) EMI test requirements and procedures must be determined as one of the first EMI test planning steps. METF can provide assistance, if requested, in determining the EUT test requirements.

    a. Which MIL-STD-461E EMI subtests are applicable to the EUT? Table IV from MIL-STD-461E is reprinted below with a box to check if a particular subtest is applicable to the EUT.

Applicable to this EUT?	Subtest	Description
	CE101	Conducted Emissions, Power Leads, 30Hz to 10kHz
	CE102	Conducted Emissions, Power Leads, 10kHz to 10MHz
	CE106	Conducted Emissions, Antenna Terminal, 10kHz to 40GHz
	CS101	Conducted Susceptibility, Power Leads, 30Hz to 150kHz
	CS103	Conducted Susceptibility, Antenna Port, Intermodulation, 15kHz to 10GHz
	CS104	Conducted Susceptibility, Antenna Port, Rejection of Undesired Signals, 30Hz to 20GHz
	CS105	Conducted Susceptibility, Antenna Port, Cross-Modulation, 30Hz to 20GHz
	CS109	Conducted Susceptibility, Structure Current, 60Hz to 100kHz
	CS114	Conducted Susceptibility, Bulk Cable Injection, 10kHz to 200MHz
	CS115	Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation
	CS116	Conducted Susceptibility, Damped Sinusoidal Transients, Cables and Power Leads, 10kHz to 100MHz
	RE101	Radiated Emissions, Magnetic Field, 30Hz to 100kHz
	RE102	Radiated Emissions, Electric Field, 10KHz to 18GHz
	RE103	Radiated Emissions, Antenna Spurious and Harmonic Outputs, 10kHz to 40GHz
	RS101	Radiated Susceptibility, Magnetic Field, 30Hz to 100kHz
	RS103	Radiated Susceptibility, Electric Field, 2MHz to 40GHz
	RS105	Radiated Susceptibility, Transient Electromagnetic Field

b. What are the EUT MIL-STD-461E EMI subtest emission and susceptibility limits? The EMI subtests which require a limit determination are shown in the table below. After determination of the particular limits for this EUT, enter them in the table.

EMI Subtest	Subtest Limit Choices	Limit for this EUT
CE101	Figure CE101-1, CE101-2, CE101-3, or CE101-4	
CS114	Curve number for each frequency range (Table VI and Figure CS114-1)	
CS116	Imax value from Figure CS116-2	
RE101	Figure RE101-1 or Figure RE101-2	
RE102	Figure RE102-1, RE102-2, RE102-3, or RE102-4	
RS101	Figure RS101-1 or RS101-2	
RS103	Table VII	

c. Has an EMI test procedure been developed for the EUT? If so, please furnish to METF personnel.

2. A block diagram of the EUT system is an extremely helpful aid in test planning. The diagram should include the EUT enclosure(s) and all connections, both inside and outside the test chamber. This would include the EUT enclosure(s) inside the test chamber, cables connections between the enclosures inside the test chamber, any Ground Support Equipment (GSE) located outside the test chamber, and cable connections between the EUT system and the GSE.

3. What are the EUT power requirements? METF can supply 28Vdc and 120Vdc filtered power inside the EMI test chambers.

   a. List the individual EUT power requirements by bus voltage, maximum bus current draw, average/typical bus current draw, and the METF fuse level required on each bus in the table below.

	Bus 1	**Bus 2**	**Bus 3**	**Bus 4**	**Bus 5**
Voltage (Volts)					
Maximum current draw (Amps)					
Average/typical current draw (Amps)					
METF Fuse level required (Amps)					

   b. List any additional/special power requirements.

4. CS114 and CS115 testing is required on (1) each cable bundle interfacing with each electrical connector on the EUT including complete power cables (high sides and returns), and (2) on power cables with the power returns and chassis grounds (green wires) excluded from the cable bundle.. For connectors which include both interconnecting leads and power, CS114 and CS115 must be performed on (1) the entire cable bundle, (2) on the power leads (including returns and grounds) grouped separately, and (3) on the power leads grouped with the returns and ground removed. List each cable interfacing with the EUT in the tables below and indicate which CS114 and CS115 runs are required on that cable (yes/no/Not Applicable in each column).

EUT Power Cable(s)	CS114 and CS115 runs required	
	High sides and returns	High sides only
	Yes	Yes
	Yes	Yes

EUT Interconnecting Cable(s)	CS114 and CS115 runs required		
	Entire cable bundle	Input power leads grouped separately	Input power leads grouped separately with returns/grounds removed

5. CS116 testing is required on (1) each cable bundle interfacing with each electrical connector on the EUT including complete power cables and (2) on each individual high side power lead. Individual power returns and neutrals are not required to be tested. List each cable interfacing with the EUT in the table below and indicate which CS116 runs are required on that cable (yes/no/Not Applicable in each column).

EUT Cable	CS116 runs required	
	Entire cable bundle	High side power lead
Power 1	Yes	Yes
Power 2	Yes	Yes
Cable 1		N/A
Cable 2		N/A
Cable 3		N/A

6. For RE102 and RS103 testing above 200MHz on EUT systems with multiple boxes/parts (enclosures), the test antennas must be centered on each EUT enclosure. The number of antenna positions drives the time required to complete the RE102 and RS103 tests.

   a. How many enclosures encompass the EUT?

   b. What are the approximate dimensions of each enclosure?

   c. What are the approximate footprint dimensions of the system?

   d. What is the proximity of each enclosure to the others in the system?

   e. These dimensions should be indicated on the EUT system block diagram from question 2.

7. What are the EUT operating mode(s) for each EMI subtest? In general, the worst-case modes for maximum emissions/maximum susceptibility need to be tested. Since this is usually unknown prior to test start, in general it is best to operate the EUT with as much equipment/subassemblies running simultaneously as possible. Considerations for maximum emissions include modes that cause maximum EUT prime power current, result in the greatest activity in interface circuit operation, and generate the largest current drain on internal digital clock signals. Any EUT modes that are considered mission critical should be evaluated during susceptibility testing. All electrical interfaces should be exercised frequently to cause constant bus traffic flow for both emissions and susceptibility testing.

    a. Specify the EUT operating mode(s) for each EMI emission and susceptibility test. The rationale for testing the chosen mode(s) should be documented in the EUT EMI test plan.

    b. What is the EUT doing during each mode? What EUT subsystems are operational during each mode?

    c. What is the time required to complete one cycle of each mode?

    d. What is the time required to switch between modes?

    e. How long can the EUT operate in each mode?

EUT operating mode	What is happening during this mode	Time required to complete one cycle of this mode	Time EUT can operate in this mode	Time to switch to other mode(s)

8. Is the EUT a stand-alone unit or will any Ground Support Equipment (GSE) be connected to the EUT?

    a. Will the GSE be located inside or outside the EMI test chamber?

    b. What will be connected between the GSE and EUT (data/signal cabling, cooling lines, etc.)?

    c. What are the GSE power requirements (voltage, current)?

9. If GSE will be located inside the test chamber with the EUT, is the GSE considered part of the EUT for EMI test purposes (especially radiated emissions and radiated susceptibility)? How will GSE emissions/susceptibility be differentiated from the EUT emissions/susceptibility?

10. How long are the connections/cabling between the EUT and GSE that will be used for the EMI test? Connections between the EUT located inside the test chamber and the GSE located outside the test chamber need to be a minimum 25 ft length.

11. Electrical cable assemblies used for EMI testing shall simulate actual flight installation and usage. Shielded cables or shielded leads (including power leads and wire grounds) within cables shall be used only if they have been specified in the flight cable configuration. EMI test cables should be checked against flight installation requirements to verify proper construction techniques such as the use of twisted pairs, shielding, and shield terminations.

    a. Are flight cables available for the EMI test?

    b. How long are the flight cables?

    c. If non-flight cables will be used to complete the GSE-EUT connection outside the test chamber, are these cables shielded and is the outer shield braid exposed so that the overall cable shield can be bonded to the test chamber stuffing tube to suppress external noise from entering the test chamber?

12. Flight power cables should be used for the EMI test when possible.

    a. Will flight or non-flight power cables be used for the EMI test?

    b. If non-flight power cables are to be used, the cable shielding configuration should match the flight cable configuration (if flight cables are unshielded then the test cables should be unshielded and if the flight cables are shielded then the test cables should be shielded).

    c. What is the power cable length? The required cable length for EMI testing is 2-3 meters.

    d. The connector on the power supply end of the EUT power cable must be coordinated with METF prior to the test start (male banana jacks are preferable).

13. How does the EUT achieve its installed bonding configuration (bond strap, surface mating, etc.)?

14. How will the EUT be bonded to the EMI copper-top test table to achieve the requisite 2.5 milliOhm EMI bond requirement?

15. EUT performance must be monitored during susceptibility testing.

    a. How will EUT performance be monitored during susceptibility tests (GSE computer, EUT front panel indicators, etc)?

    b. What constitutes an EUT failure during susceptibility testing (i.e. what EUT indicators will be monitored and what is the out of tolerance condition that constitutes failure)?

    c. The EUT failure criteria **MUST** be included in the EUT EMI test plan.

16. What EUT support will be provided (personnel, equipment) to operate the EUT (and GSE as applicable) and ensure correct setup/operation? This is especially critical for development/troubleshooting testing.

17. The EUT hardware and software should be representative of the final production configuration. It is important that the hardware and software being tested is the same as the equipment that will be produced. Sometimes pre-production equipment is tested that contains circuit boards that do not include the final layout and/or software that is not the final version. Qualification/verification questions inevitably arise concerning the effects of the differences between the tested equipment and the production equipment configuration. Analytically determining the impact is usually difficult or impossible.

    a. What is the functionality of the system that will be tested, as opposed to the production hardware? (e.g. are some production functions not implemented on the EMI test article, is software still under development, are circuit board changes anticipated, etc.).

    b. What modifications (hardware, software, cabling, etc.) will be made after the completion of EMI testing and before the hardware turn-over for production?

    c. A version/build description of the hardware, software, and cabling to be tested must be provided to METF on or before the first day of testing.

18. The system brought for test should be thoroughly tested functionally prior to the hardware being delivered to METF to ensure that the system meets all EUT operational specifications. Delivering hardware and software that is just coming out of fabrication and has not been through integrated functional testing can impact tight program test schedules if the system is set up in the EMI facility and does not operate correctly.

    a. Has integrated functional testing been performed on the entire system and is the entire EUT system operating correctly (not just parts of the system checked separately)?

    b. How much runtime is on the EUT system?

    c. Are minor known problems/bugs with the hardware and/or software documented, so that these will not be attributed to EMI susceptibility effects?

19. If the EUT has undergone previous EMI testing (development or qualification) it is important to review previous test results to avoid any test setup/operation problems experienced during the previous testing.

    a. What previous EMI test data exists on the EUT? What was the EMI test specification?

    b. Did the EUT pass or fail previous EMI testing? Please provide a summary table of EMI subtests performed and pass/fail for each.

    c. What EUT hardware/software changes have been made since the previous EMI testing was performed? Were these changes in response to EMI emissions or susceptibilities noted during the previous EMI testing?

    d. Provide details of the previous EMI test setup, especially noting any problems setting up the test or operating EUT and GSE hardware/software. At the minimum this will include a block diagram of the test configuration showing which equipment was inside the test chamber, which equipment was outside the test chamber, how all pieces of equipment were cabled together, and how cables passing out of the test chamber were configured.

    e. Are special EUT test cables, GSE, etc. used in the previous EMI test still available and has this equipment been checked out with the modified EUT system being brought for the current test?

20. The EUT EMI test plan/procedure should be supplied to METF for review at least 30 days prior to the scheduled test start date. Failure to supply a test procedure with adequate review time may result in a delayed test start date until all issues have been satisfactorily resolved.

21. A Test Readiness Review (TRR) should be held at least one week prior to the scheduled test start date to ensure that all test issues have been satisfactorily resolved. Failure to coordinate all test issues with METF personnel may result in a delayed test start date until all issues have been satisfactorily resolved.

Programmatic Issues

1. Are Marshal Space Flight Center (MSFC) Quality Assurance (QA) personnel required to witness the test? If so, QA coverage must be coordinated well in advance of the EMI test start date.

2. Does the EUT require an MSFC Customer Supplied Product (CSP) tag (a.k.a. "the blue tag")? In general, if the EUT will be accompanied and operated by the customer at all times while on MSFC property during the EMI test, then a CSP tag is not required.

3. How will the EUT be delivered to MSFC (hand carry, overnight shipping, etc.)?

4. Special EUT handling requirements must be coordinated with METF well in advance of the test.

    a. How much does the EUT weigh?

    b. Can the EUT be safely lifted from the shipping container and placed on the EMI test table by two people?

    c. What special handling methods are required?

5. The MSFC EMI test report will include a test summary, run log, any customer supplied test procedures/documentation, as-run METF facility operating procedure (FOP), test data, and test photos.

    a. Do the EUT operators require any additional items for test documentation?

    b. How soon after test completion is the EMI test report to be delivered (typical delivery times are 30-60 days)?

6. Normal METF operating hours are 8:30am - 5 pm Monday-Friday. Are any special operating hours required to test this EUT?

7. The EUT part number(s) and serial number(s) must be supplied to METF prior to test start for inclusion in the test records/report.